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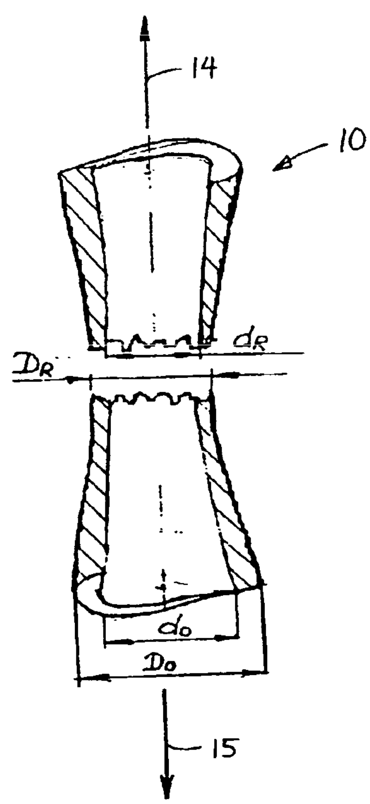
[Continued on next page]

(54) Title: PIPE FORMABILITY EVALUATION FOR EXPANDABLE TUBULARS



(57) **Abstract:** A method of testing a tubular member (10) and selecting tubular members for suitability for expansion by subjecting a representative sample the tubular member to axial loading (14, 15), stretching at least a portion of the tubular member through elastic deformation, plastic yield and to ultimate yield, and based upon changes in length and area calculating an expandability coefficient indicative of expandability of the tubular members (10) and selecting tubular members (10) with relatively high coefficients indicative of good expandability.

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PIPE FORMABILITY EVALUATION FOR EXPANDABLE TUBULARS

Cross Reference To Related Applications

[1] The present application claims the benefit of the filing dates of (1) U.S. provisional patent application serial no. 60/412,653, attorney docket no 25791.118, filed on 9/20/2002, the disclosure of which is incorporated herein by reference.

[2] The present application is related to the following: (1) U.S. patent application serial no. 09/454,139, attorney docket no. 25791.03.02, filed on 12/3/1999, (2) U.S. patent application serial no. 09/510,913, attorney docket no. 25791.7.02, filed on 2/23/2000, (3) U.S. patent application serial no. 09/502,350, attorney docket no. 25791.8.02, filed on 2/10/2000, (4) U.S. patent no. 6,328,113, (5) U.S. patent application serial no. 09/523,460, attorney docket no. 25791.11.02, filed on 3/10/2000, (6) U.S. patent application serial no. 09/512,895, attorney docket no. 25791.12.02, filed on 2/24/2000, (7) U.S. patent application serial no. 09/511,941, attorney docket no. 25791.16.02, filed on 2/24/2000, (8) U.S. patent application serial no. 09/588,946, attorney docket no. 25791.17.02, filed on 6/7/2000, (9) U.S. patent application serial no. 09/559,122, attorney docket no. 25791.23.02, filed on 4/26/2000, (10) PCT patent application serial no. PCT/US00/18635, attorney docket no. 25791.25.02, filed on 7/9/2000, (11) U.S. provisional patent application serial no. 60/162,671, attorney docket no. 25791.27, filed on 11/1/1999, (12) U.S. provisional patent application serial no. 60/154,047, attorney docket no. 25791.29, filed on 9/16/1999, (13) U.S. provisional patent application serial no. 60/159,082, attorney docket no. 25791.34, filed on 10/12/1999, (14) U.S. provisional patent application serial no. 60/159,039, attorney docket no. 25791.36, filed on 10/12/1999, (15) U.S. provisional patent application serial no. 60/159,033, attorney docket no. 25791.37, filed on 10/12/1999, (16) U.S. provisional patent application serial no. 60/212,359, attorney docket no. 25791.38, filed on 6/19/2000, (17) U.S. provisional patent application serial no. 60/165,228, attorney docket no. 25791.39, filed on 11/12/1999, (18) U.S. provisional patent application serial no. 60/221,443, attorney docket no. 25791.45, filed on 7/28/2000, (19) U.S. provisional patent application serial no. 60/221,645, attorney docket no. 25791.46, filed on 7/28/2000, (20) U.S. provisional patent application serial no. 60/233,638, attorney docket no. 25791.47, filed on 9/18/2000, (21) U.S. provisional patent application serial no. 60/237,334, attorney docket no. 25791.48, filed on 10/2/2000, (22) U.S. provisional patent application serial no. 60/270,007, attorney docket no. 25791.50, filed on 2/20/2001, (23) U.S. provisional patent application serial no. 60/262,434, attorney docket no. 25791.51, filed on 1/17/2001, (24) U.S. provisional patent application serial no. 60/259,486, attorney docket no. 25791.52, filed on 1/3/2001, (25) U.S. provisional patent application serial no. 60/303,740, attorney docket no. 25791.61, filed on 7/6/2001, (26) U.S. provisional patent application serial no. 60/313,453, attorney docket no. 25791.59, filed on 8/20/2001, (27) U.S. provisional patent application serial no. 60/317,985, attorney docket no. 25791.67, filed on 9/6/2001, (28) U.S. provisional patent application serial no. 60/3318,386, attorney docket no. 25791.67.02, filed on 9/10/2001, (29) U.S. utility

patent application serial no. 09/969,922, attorney docket no. 25791.69, filed on 10/3/2001, (30) U.S. utility patent application serial no. 10/016,467, attorney docket no. 25791.70, filed on 12/10/2001, (31) U.S. provisional patent application serial no. 60/343,674, attorney docket no. 25791.68, filed on 12/27/2001, (32) U.S. provisional patent application serial no. 60/346,309, attorney docket no 25791.92, filed on 1/7/2002, (33) U.S. provisional patent application serial no. 60/372,048, attorney docket no. 25791.93, filed on 4/12/2002, (34) U.S. provisional patent application serial no. 60/380,147, attorney docket no. 25791.104, filed on 5/6/2002, (35) U.S. provisional patent application serial no. 60/387,486, attorney docket no. 25791.107, filed on 6/10/2002, (36) U.S. provisional patent application serial no. 60/387,961, attorney docket no. 25791.108, filed on 6/12/2002, (37) U.S. provisional patent application serial no. 60/394,703, attorney docket no. 25791.90, filed on 6/26/2002, (38) U.S. provisional patent application serial no. 60/397,284, attorney docket no. 25791.106, filed on 7/19/2002, (39) U.S. provisional patent application serial no. 60/398,061, attorney docket no. 25791.110, filed on 7/24/2002, (40) U.S. provisional patent application serial no, 60/405,610, attorney docket no. 25791.119, filed on 8/23/2002, (41) U.S. provisional patent application serial no. 60/405,394, attorney docket no. 25791.120, filed on 8/23/2002, (42) U.S. provisional patent application serial no. 60/412,542, attorney docket no. 25791.102, filed on 9/20/2002, (43) U.S. provisional patent application serial no. 60/412,487, attorney docket no. 25791.112, filed on 9/20/2002, (44) U.S. provisional patent application serial no. 60/412,488, attorney docket no. 25791.114, filed on 9/20/2002, (45) U.S. provisional patent application serial no. 60/412,177, attorney docket no. 25791.117, filed on 9/20/2002, (46) U.S. provisional patent application serial no. 60/412,653, attorney docket no. 25791.118, filed on 9/20/2002, (47) U.S. provisional patent application serial no. 60/412,544, attorney docket no. 25791.121, filed on 9/20/2002, (48) U.S. provisional patent application serial no. 60/412,196, attorney docket no. 25791.127, filed on 9/20/2002, (49) U.S. provisional patent application serial no. 60/412,187, attorney docket no. 25791.128, filed on 9/20/2002, and (50) U.S. provisional patent application serial no. 60/412,371, attorney docket no. 25791.129, filed on 9/20/2002, the disclosures of which are incorporated herein by reference.

Background of the Invention

[3] The present invention relates generally to tubular steel well casing and more particularly to an expansion mandrel which reduces stress during expansion of the casing.

[4] Solid tubular casing of substantial length is used as a borehole liner in downhole drilling. The casing is comprised of end-to-end interconnected segments of steel tubing to protect against possible collapse of the borehole and to optimize well flow. The tubing often reaches substantial depths and endures substantial pressures.

[5] It is prèsent practice to expand the steel tubing downhole by using a mandrel. This is a cold-working process which presents substantial mechanical challenges. This technology is known as solid expandable tubular (SET) technology. This cold-working process deforms the steel without any additional heat beyond what is present in the downhole environment.

[6] It is present practice to expand the steel tubing downhole by using a mandrel. This is a cold-working process which presents substantial mechanical challenges. This technology is known as solid expandable tubular (SET) technology. This cold-working process deforms the steel without any additional heat beyond what is present in the downhole environment.

[7] An expansion cone, or mandrel, is used to permanently mechanically deform the pipe. The cone is moved through the tubing by a differential hydraulic pressure across the cone itself, and/or by a direct mechanical pull or push force. The differential pressure is pumped through an inner-string connected to the cone, and the mechanical force is applied by either raising or lowering the inner string.

[8] Progress of the cone through the tubing deforms the steel beyond its elastic limit into the plastic region, while keeping stresses below ultimate yield. Expansions greater than 20%, based on pipe ID, have been accomplished. However, most applications using 4 1/4 - 13 3/8 inch tubing have required expansions less than 20%. The ID of the pipe expands to the same ID of the expansion mandrel, which is a function of expansion mandrel OD. Contact between cylindrical mandrel and pipe ID during expansion leads to significant forces due to friction. It would be beneficial to provide method for testing tubular members for suitability for the expansion process. It would also be beneficial to provide a method for selecting tubing or tubular members well suited for expansion.

Summary Of The Invention

[9] According to one aspect of the present invention, a method of testing a tubular member for suitability for expansion is provided using an expandability coefficient determined pursuant to a stress-strain test of a tubular member using axial loading.

[10] According to another aspect of the present invention, a tubular member is selected for suitability for expansion on a basis comprising use of an expandability coefficient determined pursuant to a stress-strain test of a tubular member using axial loading.

[11] According to another aspect of the present invention, a method of testing a tubular member for suitability for expansion is provided using an expandability coefficient determined pursuant to a stress-strain test using axial loading comprising calculation of plastic strain ratio for obtaining the expansion coefficient pursuant to test results and using the formula:

$$f = \frac{\ln \frac{b_o}{b_k}}{\ln \frac{L_k b_k}{l_o b_o}} \qquad \text{Equation 1}$$

where,

f - expandability coefficient

bo & bk - initial and final tube area (inch^2)

Lo & Lk - initial and final tube length (inch)

b = (D^2-d^2)/4 - cross section tube area.

[12] According to another aspect of the present invention, a tubular member is selected for suitability for expansion on a basis comprising use of an expandability coefficient determined pursuant to a stress-strain test using axial loading comprising calculation of plastic strain ratio for obtaining the expansion coefficient pursuant to test results and using the formula:

$$f = \frac{\ln \frac{b_o}{b_k}}{\ln \frac{L_k b_k}{l_o b_o}} \qquad \text{Equation 1}$$

where,

f - expandability coefficient

bo & bk - initial and final tube area (inch^2)

Lo & Lk - initial and final tube length (inch)

b = (D^2-d^2)/4 - cross section tube area.

[13] According to another aspect of the present invention, a tubular member is selected for suitability for expansion on a basis comprising use of an expandability coefficient determined pursuant to a stress-strain test using axial loading and one or more physical properties of the tubular member selected from stress-strain properties in one or more directional orientations of the material, Charpy V-notch impact value in one or more directional orientations of the material, stress rupture burst strength, stress rupture collapse strength, strain-hardening exponent(n-value), hardness and yield strength.

Brief Description of the Drawings

[14] Fig. 1 depicts in a schematic fragmentary cross-sectional view along a plane along and through the central axis of a tubular member that is tested to failure with axial opposed forces.

[15] Fig. 2 is a stress-strain curve representing values for stress and strain that may be plotted for solid specimen sample.

[16] Fig. 3. is a schematically depiction of a stress strain curve representing values from a test on a tubular member according to an illustrative example of one aspect of the invention.

Detailed Description of the Illustrative Embodiments

[17] One of the problems of the pipe material selection for expandable tubular application is an apparent contradiction or inconsistency between strength and elongation. To increase burst and collapse strength, material with higher yield strength is used. The higher yield strength generally corresponds to a decrease in the fracture toughness and correspondingly limits the extent of achievable expansion.

[18] It is desirable to select the steel material for the tubing by balancing steel strength with amount absorbed energy measure by Charpy testing. Generally these tests are done on samples cut from tubular members. It has been found to be beneficial to cut directional samples both longitudinally oriented

(aligned with the axis) and circumferentially oriented (generally perpendicular to the axis). This method of selecting samples is beneficial when both directional orientations are used yet does not completely evaluate possible and characteristic anisotropy throughout a tubular member. Moreover, for small diameter tubing samples representative of the circumferential direction may be difficult and sometimes impossible to obtain because of the significant curvature of the tubing.

[19] To further facilitate evaluation of a tubular member for suitability for expansion it has been found beneficial according to one aspect of the invention to consider the plastic strain ratio. One such ratio is called a Lankford value (or r-value) which is the ratio of the strains occurring in the width and thickness directions measured in a single tension test. The plastic strain ratio (r or Lankford - value) with a value of greater than 1.0 is found to be more resistant to thinning and better suited to tubular expansion. Such a Lankford value is found to be a measure of plastic anisotropy. The Lankford value (r) may be calculate by the Equation 2 below:

$$r = \frac{\ln \dfrac{b_o}{b_k}}{\ln \dfrac{L_k b_k}{l_o b_o}} \qquad \text{Equation 2}$$

where,

r - normal anisotropy coefficient

bo & bk - initial and final width

Lo & Lk - initial and final length

[20] However, it is time consuming and labor intensive for this parameter to be measured using samples cut from real parts such as from the tubular members. The tubular members will have anisotropic characteristics due to crystallographic or "grain " orientation and mechanically induced differences such as impurities, inclusions, and voids, requiring multiple samples for reliably complete information. Moreover, with individual samples, only local characteristics are determined and the complete anisotropy of the tubular member may not be determinable. Further some of the tubular members have small diameters so that cutting samples oriented in a circumferential direction is not always possible. Information regarding the characteristics in the circumferential direction has been found to be important because the plastic deformation during expansion of the tubular members occurs to a very large extent in the circumferential direction,

[21] One aspect of the present invention comprises the development of a solution for anisotropy evaluation, including a kind of plastic strain ratio similar to the Lankford parameter that is measured using real tubular members subjected to axial loading.

[22] Fig. 1 depicts in a schematic fragmentary cross-sectional view along a plane along and through the axis 12 of a tubular member 10 that is tested with axial opposed forces 14 and 15. The tubular member 10

is axially stretched beyond the elastic limit, through yielding and to ultimate yield or fracture. Measurements of the force and the OD and ID during the process produce test data that can be used in the formula below to produce an expandability coefficient *"f"* as set forth in Equation 1 above. Alternatively a coefficient called a formability anisotropy coefficient *F(r)* that is function of the normal anisotropy Lankford coefficient *r* may be determined as in Equation 3 below:

$$F(r) = \frac{\ln \frac{b_o}{b_k}}{\ln \frac{L_k b_k}{l_o b_o}} \qquad \text{Equation 3}$$

F(r) - formability anisotropy coefficient

bo & bk - initial and final tube area (inch^2)

Lo & Lk - initial and final tube length (inch)

b = (D^2-d^2)/4- cross section tube area.

[23] In either circumstance *f* or *F(r)* the use of this testing method for an entire tubular member provides useful information including anisotropic characteristics or anisotropy of the tubular member for selecting or producing beneficial tubular members for down hole expansion, similar to the use of the Lankford value for a sheet material.

[24] Just as values for stress and strain may be plotted for solid specimen samples, as schematically depicted in Fig 2, the values for conducting a test on the tubular member may also be plotted, as depicted in Fig 3. On this basis the expansion coefficient *f* (or the formability coefficient *F(r)*) may be determined. It will be the best to measure distribution (Tensile-elongation) in longitudinal and circumferential directions simultaneously.

[25] The foregoing expandability coefficient (or formability coefficient) is found to be useful in predicting good expansion results and may be further useful when used in combination with one or more other properties of a tubular member selected from stress-strain properties in one or more directional orientations of the material, strength & elongation, Charpy V-notch impact value in one or more directional orientations of the material, stress burst rupture, stress collapse rupture, yield strength, ductility, toughness, and strain-hardening exponent (n - value), and hardness.

[26] Although illustrative embodiments of the invention have been shown and described, a wide range of modification, changes and substitution is contemplated in the foregoing disclosure. In some instances, some features of the present invention may be employed without a corresponding use of the other features. Accordingly, it is appropriate that the appended claims be construed broadly and in a manner consistent with the scope of the invention.

Claims

What is claimed is:

1. A method of testing a tubular member for suitability for expansion is provided comprising the steps of subjecting at least a portion of the tubular member to axial loading, stretching at least a portion of the tubular member through the elastic deformation, plastic yield and to ultimate yield, and calculating an expandability coefficient f.

2 A method of testing a tubular member for suitability for expansion as in claim 1 wherein the step of subjecting the at least a portion of the tubular member to axial loading comprises subjecting the entire tubular member to axial loading.

3. A method of testing tubular members for suitability for expansion wherein the step of calculating an expandability coefficient comprises calculating the expandability coefficient using the following formula (Equation 1):

$$f = \frac{\ln \frac{b_o}{b_k}}{\ln \frac{L_k b_k}{l_o b_o}} \qquad \text{Equation 1}$$

where,

f - expandability coefficient

bo & bk - initial and final tube area (inch^2)

Lo & Lk - initial and final tube length (inch)

b = (D^2-d^2)/4 - cross section tube area.

4. A method of selecting tubular members for suitability for expansion is provided comprising the steps of subjecting at least a portion of a representative sample of tubular members to axial loading, stretching at least a portion of the tubular member through the elastic deformation, plastic yield and to ultimate yield, and calculating an expandability coefficient f, and choosing such tubular members for which the sample provided a desirable coefficient of expandability above a value of 1.

5. A method of selecting tubular members for suitability for expansion as in claim 1 wherein the step of subjecting the at least a portion of the tubular member to axial loading comprises subjecting at least one entire tubular member to axial loading.

6. A method of selecting tubular members for suitability for expansion wherein the step of calculating an expandability coefficient comprises calculating the expandability coefficient using the following formula (Equation 1):

$$f = \frac{\ln \frac{b_o}{b_k}}{\ln \frac{L_k b_k}{l_o b_o}} \qquad \text{Equation 1}$$

where,

f - expandability coefficient

bo & bk - initial and final tube area (inch^2)

Lo & Lk - initial and final tube length (inch)

b = (D^2-d^2)/4 - cross section tube area.

7. According to another aspect of the present invention, a tubular member is selected for suitability for expansion on a basis comprising use of an expandability coefficient determined pursuant to a stress-strain test using axial loading in combination with one or more physical properties of the tubular member selected from a group of properties comprising stress-strain properties in one or more directional orientations of the material, Charpy V-notch impact value in one or more directional orientations of the material, stress rupture burst strength, stress rupture collapse strength, yield strength, strain-hardening exponent (n-value), and hardness.

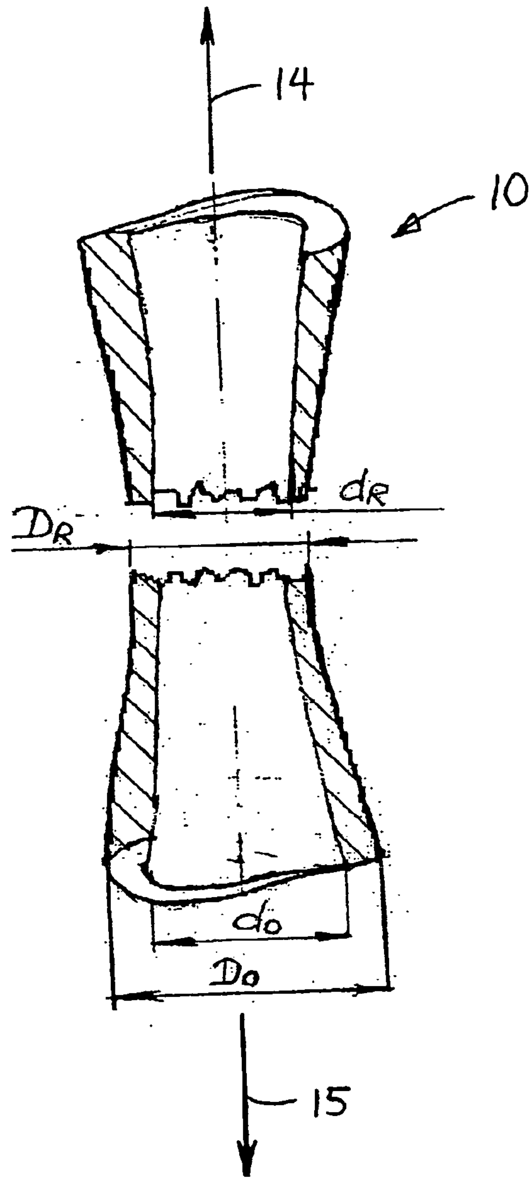

FIG. 1

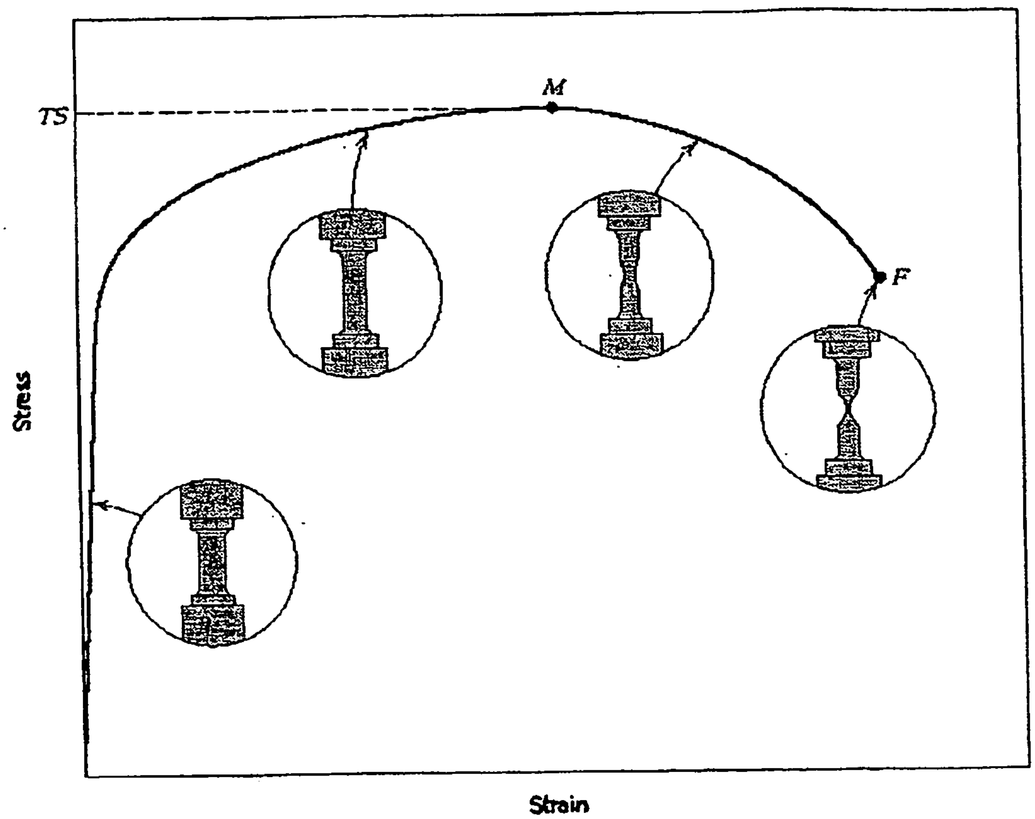

FIG. 2

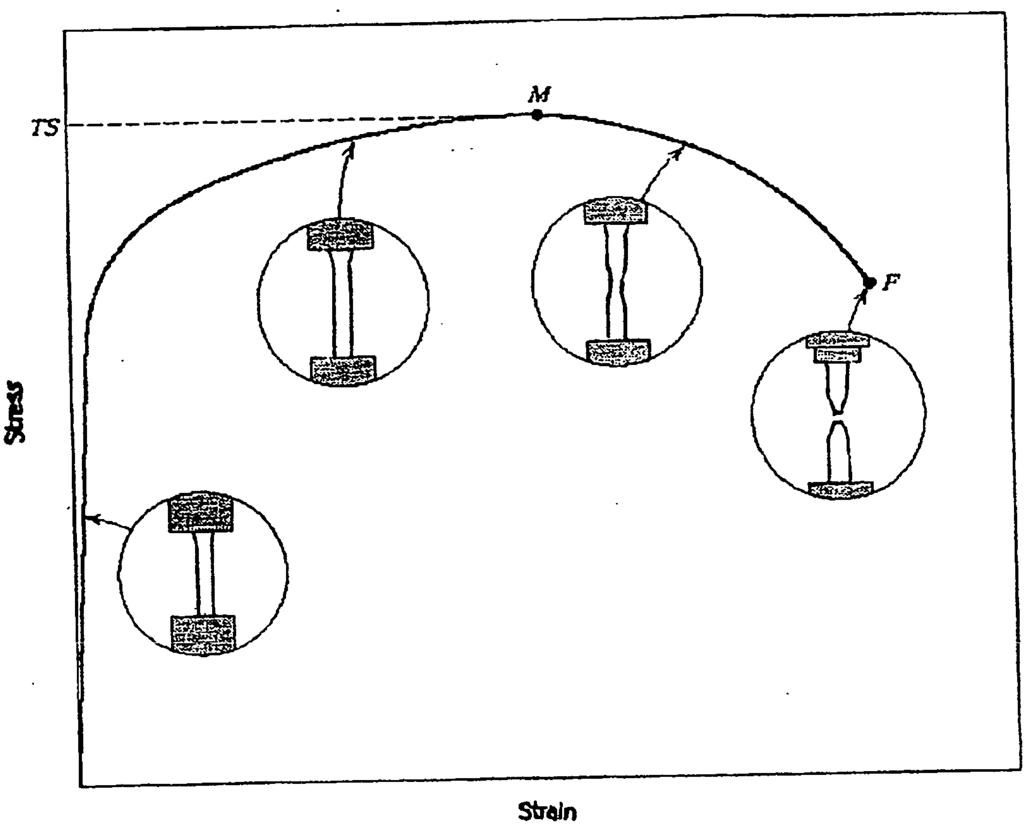

FIG. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US03/25667

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : G01N 3/08,
US CL : 73/821, 826, 818

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 73/821, 826, 818

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
East text search

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
USPAT, US-PGPub, EPO, JPO, Derwent, IBM_TDP

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X — Y	US 5,134,891 A (CANEVET et al.) 4 August 1992 (4.08.1992), Col. 1, lines 15-26, Col. 2, lines 5-21, Figure 1.	1-2,4-5,7 — 3,6
E	US 6,672,759 B2 (FEGER) 6 January 2004 (6.01.2004), Abstract, Col. 9, lines 25-41.	1-7

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

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"E" earlier application or patent published on or after the international filing date

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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Date of the actual completion of the international search	Date of mailing of the international search report
09 January 2004 (09.01.2004)	26 FEB 2004
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450 Alexandria, Virginia 22313-1450 Facsimile No. (703) 305-3230	Authorized officer Nona M Chapman for Edward Lefkowitz Telephone No. (703)308-0956

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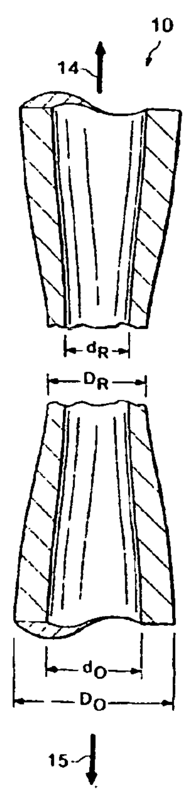
(54) Title: PIPE FORMABILITY EVALUATION FOR EXPANDABLE TUBULARS

(57) Abstract: A method of testing a tubular member (10) and selecting tubular members for suitability for expansion by subjecting a representative sample the tubular member to axial loading (14, 15), stretching at least a portion of the tubular member through elastic deformation, plastic yield and to ultimate yield, and based upon changes in length and area calculating an expandability coefficient indicative of expandability of the tubular members (10) and selecting tubular members (10) with relatively high coefficients indicative of good expandability.



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ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

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— *of inventorship (Rule 4.17(iv)) for US only*

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— *with international search report*
— *with amended claims*

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AMENDED CLAIMS

[received by the International Bureau on 21 April 2004 (21.04.04); claims 1-7 amended, claims 8-35 added]

1. A method of testing a tubular member for suitability for radial expansion and plastic deformation comprising: subjecting at least a portion of the tubular member to axial loading, stretching at least a portion of the tubular member through the elastic deformation, plastic yield and to ultimate yield, and calculating an expandability coefficient *f*.

2. The method of claim 1, wherein subjecting the at least a portion of the tubular member to axial loading comprises subjecting the entire tubular member to axial loading.

3. The method of claim 1, wherein the step of calculating an expandability coefficient comprises calculating the expandability coefficient using the following formula :

$$f = \frac{\ln \frac{b_o}{b_k}}{\ln \frac{L_k b_k}{l_o b_o}} \qquad \text{[Equation 1]}$$

where,

f - expandability coefficient;

bo & bk - initial and final tube cross-sectional area (inch^2);

Lo & Lk - initial and final tube length (inch);

$b = (D^2-d^2)/4$ - cross section tube area;

D = tube outside diameter; and

d = tube inside diameter.

4. A method of selecting tubular members for suitability for radial expansion and plastic deformation comprising subjecting at least a portion of a representative sample of tubular members to axial loading, stretching at least a portion of the tubular members through the elastic deformation, plastic yield and to ultimate yield, and calculating an expandability coefficient *f*, and choosing such tubular members for which the sample provided a desirable coefficient of expandability above a value of 1.

5. The method of claim 4, wherein subjecting the at least a portion of a representative sample of tubular members to axial loading comprises subjecting the entire length of at least one of the tubular members to axial loading.

6. The method of claim 4, wherein the step of calculating an expandability coefficient comprises

calculating the expandability coefficient using the following formula:

$$f = \frac{\ln \frac{b_o}{b_k}}{\ln \frac{L_k b_k}{l_o b_o}} \qquad \text{[Equation 1]}$$

where,

f - expandability coefficient;

bo & bk - initial and final tube cross sectional area ($inch^2$);

Lo & Lk - initial and final tube length (inch);

$b = (D^2\text{-}d^2)/4$ - cross section tube area;

D = tube outside diameter; and

d = tube inside diameter.

7. A method of selecting a tubular member for suitability for radial expansion and plastic deformation comprising using an expandability coefficient determined pursuant to a stress-strain test using axial loading in combination with one or more physical properties of the tubular member selected from a group of properties comprising stress-strain properties in one or more directional orientations of the material, Charpy V-notch impact value in one or more directional orientations of the material, stress rupture burst strength, stress rupture collapse strength, yield strength, strain-hardening exponent (n-value), and hardness.

8. A system for testing a tubular member for suitability for radial expansion and plastic deformation comprising:

means for subjecting at least a portion of the tubular member to axial loading,

means for stretching at least a portion of the tubular member through the elastic deformation, plastic yield and to ultimate yield, and

means for calculating an expandability coefficient f.

9. The system of claim 8, wherein means for subjecting the at least a portion of the tubular member to axial loading comprises means for subjecting the entire tubular member to axial loading.

10. The system of claim 8, wherein means for calculating an expandability coefficient comprises calculating the expandability coefficient using the following formula:

$$f = \frac{\ln \frac{b_o}{b_k}}{\ln \frac{L_k b_k}{l_o b_o}}.$$

where,

f - expandability coefficient;

bo & bk - initial and final tube cross sectional area ($inch^2$);

Lo & Lk - initial and final tube length (inch);

b = $(D^2-d^2)/4$ - cross section tube area;

D = tube outside diameter, and

d = tube inside diameter.

11. A system for selecting tubular members for suitability for radial expansion and plastic deformation comprising:

means for subjecting at least a portion of a representative sample of tubular members to axial loading,

means for stretching at least a portion of the tubular members through the elastic deformation, plastic yield and to ultimate yield, and

means for calculating an expandability coefficient f, and choosing such tubular members for which the sample provided a desirable coefficient of expandability above a value of 1.

12. The system of claim 11, wherein means for subjecting the at least a portion of a representative sample of tubular members to axial loading comprises means for subjecting the entire length of at least one of the tubular members to axial loading.

13. The system of claim 11, wherein means for calculating an expandability coefficient comprises means for calculating the expandability coefficient using the following formula:

$$f = \frac{\ln \frac{b_o}{b_k}}{\ln \frac{L_k b_k}{l_o b_o}}$$

where,

f - expandability coefficient;

bo & bk - initial and final tube cross sectional area ($inch^2$);

Lo & Lk - initial and final tube length (inch);

$b = (D^2-d^2)/4$ - cross section tube area;

D = tube outside diameter; and

d = tube inside diameter.

14. A system for selecting a tubular member for suitability for radial expansion and plastic deformation comprising:

means for conducting a stress-strain test on the tubular member;

means for calculating an expandability coefficient determined pursuant to the stress-strain test; and

means for selecting the tubular member as a function of the expandability coefficient and one or more physical properties of the tubular member selected from a group of properties comprising stress-strain properties in one or more directional orientations of the material, Charpy V-notch impact value in one or more directional orientations of the material, stress rupture burst strength, stress rupture collapse strength, yield strength, strain-hardening exponent (n-value), and hardness.

15. The method of claim 1, further comprising:

selecting the tubular member for radial expansion and plastic deformation if the expandability coefficient is greater than or equal to a predetermined value.

16. The method of claim 15, further comprising:

radially expanding and plastically deforming the selected tubular member.

17. The method of claim 4, further comprising:

radially expanding and plastically deforming one or more of the selected tubular members.

18. The method of claim 7, further comprising:

radially expanding and plastically deforming the selected tubular members.

19. A method of selecting tubular members for radial expansion and plastic deformation, comprising:

characterizing one or more anisotropic characteristics of the tubular members.

20. The method of claim 19, wherein at least one of the anisotropic characteristics comprises a measurement of the plastic anisotropy for the tubular members.

21. A system of selecting tubular members for radial expansion and plastic deformation, comprising:

means for characterizing one or more anisotropic characteristics of the tubular members; and
means for radially expanding and plastically deforming one or more selected tubular members.

22. The system of claim 21, wherein at least one of the anisotropic characteristics comprises a measurement of the plastic anisotropy for the tubular members.

23. The system of claim 21, wherein the selected tubular members comprise a plastic anisotropy measurement equal to a predetermined value.

24. A tubular member, comprising:
a plasticity characteristic that is anisotropic.

25. A system for radially expanding and plastically deforming a tubular member, comprising:
means for selecting tubular members suitable for radial expansion and plastic deformation; and
means for radially expanding and plastically deforming the tubular member.

26. The system of claim 25, wherein tubular members suitable for radial expansion and plastic deformation comprise a plasticity characteristic that is anisotropic.

27. The method of claim 1, further comprising:
selecting a tubular member for radial expansion and plastic deformation as function of the calculated formability coefficient.

28. The method of claim 1, further comprising:
selecting a tubular member for radial expansion and plastic deformation as function of the calculated formability coefficient and one or more of the following:
stress-strain properties in one or more directional orientations, Charpy V-notch impact value in one or more directional orientations, stress rupture burst strength, stress rupture collapse strength, yield strength, strain-hardening exponent (n-value), and hardness.

29. A method of selecting tubular members suitable for radial expansion and plastic deformation, comprising:
selecting a tubular member for radial expansion and plastic deformation as function of formability anisotropy.

30. A method of selecting tubular members suitable for radial expansion and plastic deformation,

comprising:

selecting a tubular member for radial expansion and plastic deformation as function of formability anisotropy and one or more of the following:

stress-strain properties in one or more directional orientations, Charpy V-notch impact value in one or more directional orientations, stress rupture burst strength, stress rupture collapse strength, yield strength, strain-hardening exponent (n-value), and hardness.

31. A method of radially expanding and plastically deforming tubular members, comprising:

selecting a tubular member for radial expansion and plastic deformation as function of the formability anisotropy for the tubular member; and

radially expanding and plastically deforming the selected tubular member.

32. A method of radially expanding and plastically deforming tubular members, comprising:

selecting a tubular member for radial expansion and plastic deformation as function of the formability anisotropy for the tubular member and one or more of the following:

stress-strain properties in one or more directional orientations, Charpy V-notch impact value in one or more directional orientations, stress rupture burst strength, stress rupture collapse strength, yield strength, strain-hardening exponent (n-value), and hardness; and

radially expanding and plastically deforming the selected tubular member.

33. A system for radially expanding and plastically deforming tubular members, comprising:

means for selecting a tubular member for radial expansion and plastic deformation as function of the formability anisotropy for the tubular member; and

means for radially expanding and plastically deforming the selected tubular member.

34. A system for radially expanding and plastically deforming tubular members, comprising:

means for selecting a tubular member for radial expansion and plastic deformation as function of the formability anisotropy for the tubular member and one or more of the following:

stress-strain properties in one or more directional orientations, Charpy V-notch impact value in one or more directional orientations, stress rupture burst strength, stress rupture collapse strength, yield strength, strain-hardening exponent (n-value), and hardness; and

means for radially expanding and plastically deforming the selected tubular member.

35. An apparatus, comprising:

a subterranean formation defining a borehole; and

a radially expanded and plastically deformed tubular member positioned within and coupled to the borehole;

wherein at least a portion of the tubular member comprises a formability characteristic that is anisotropic.